ELECTRONICS AND TELECOMMUNICATION ENGINEERING

Paper – I

Time Allowed : Three Hours | *Maximum Marks : 300*

Question Paper Specific Instructions

Please read each of the following instructions carefully before attempting questions :

*There are **EIGHT** questions divided in **TWO** sections.*

*Candidate has to attempt **FIVE** questions in all.*

*Questions No. **1** and **5** are **compulsory** and out of the remaining, **THREE** are to be attempted choosing at least **ONE** question from each section.*

The number of marks carried by a question / part is indicated against it.

Wherever any assumptions are made for answering a question, they must be clearly indicated.

Diagrams / figures, wherever required, shall be drawn in the space provided for answering the question itself.

Unless otherwise mentioned, symbols and notations carry their usual standard meanings.

Attempts of questions shall be counted in sequential order. Unless struck off, attempt of a question shall be counted even if attempted partly.

Any page or portion of the page left blank in the Question-cum-Answer Booklet must be clearly struck off.

*Answers must be written in **ENGLISH** only.*

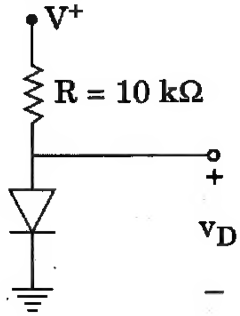
Values of constants which may be required :

Electron charge	=	$-1\cdot6 \times 10^{-19}$ Coulomb
Free space permeability	=	$4\pi \times 10^{-7}$ Henry/m
Free space permittivity	=	$(1/36\pi) \times 10^{-9}$ Farad/m
Velocity of light in free space	=	3×10^{8} m/sec
Boltzmann constant	=	$1\cdot38 \times 10^{-23}$ J/K
Planck's constant	=	$6\cdot626 \times 10^{-34}$ J-s

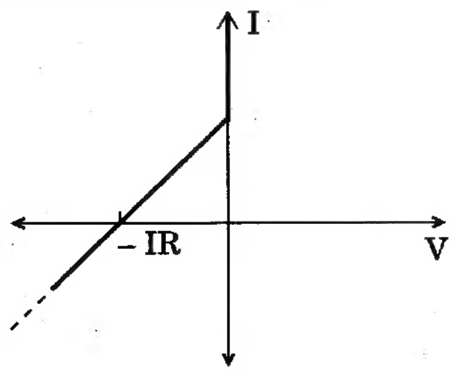
SECTION A

Q1. (a) (i) Consider the circuit shown below. The power supply V^+ has a dc value of 10 V on which is superimposed a 60 Hz sinusoid of 1 V peak amplitude, i.e. has a power supply ripple.

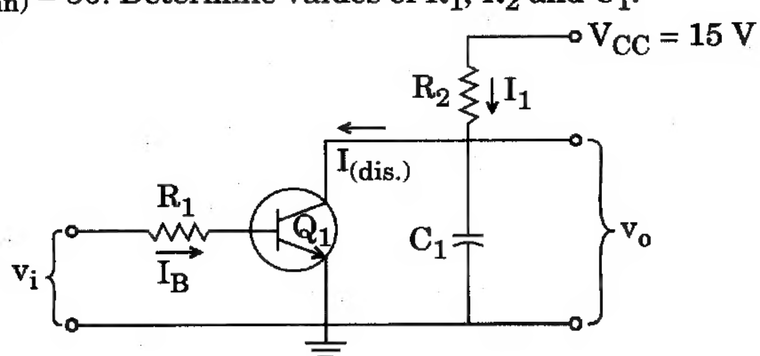
Calculate both the dc voltage of the diode and the amplitude of the sine-wave signal appearing across it, assuming a 0·7 V drop across it at 1 mA current. *6*



(ii) For the V-I characteristics as shown below, draw the circuit model using an ideal diode. *6*



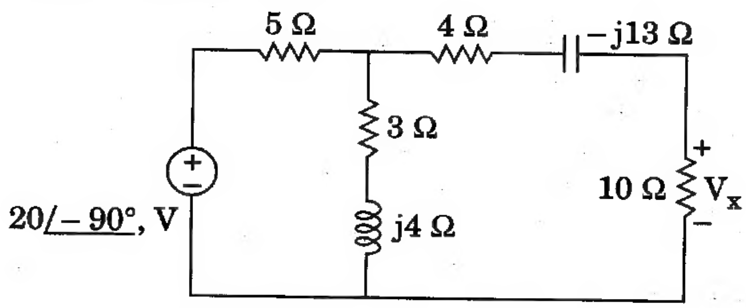
(b) The circuit shown below is to be used as ramp generator to produce a 1 V ramp output when the input is 3 V, 0·1 ms pulse with a 1 ms interval between pulses. The supply voltage is 15 V and a load resistance of 100 kΩ is connected at the output terminals. Assume Q_1 has $h_{FE(min)} = 50$. Determine values of R_1, R_2 and C_1. *12*



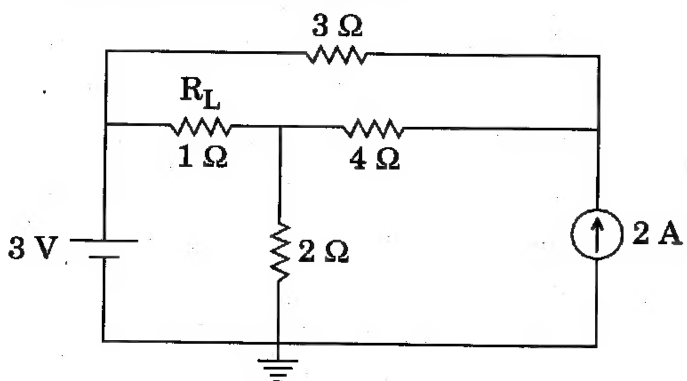
(c) A 40 μF capacitance is charged to store 0·2 J of energy. An uncharged, 60 μF capacitance is then connected in parallel with the first one through perfectly conducting leads. What is the final energy of the system ? *12*

(d) Identify magnitude of the Burgers vector for a material having cubic crystal structure, if the density, atomic weight and lattice constant are 7870 kg/m^3, 55·85 g/mol and 2·86 Å, respectively. *12*

(e) Calculate V_x in the circuit shown in the figure using the method of source transformation. *12*



Q2. (a) Find the current through the load resistance 'R_L' using Thevenin's theorem and hence calculate the voltage across the current source for the circuit shown in figure. *20*



(b) An abrupt Si p-n junction ($A = 10^{-4}$ cm^2) has the following properties at 300 K :

p-side	n-side
$N_a = 10^{17}$ cm^{-3}	$N_d = 10^{15}$ cm^{-3}
$\tau_n = 0{\cdot}1$ μs	$\tau_p = 10$ μs
$\mu_p = 200$ $cm^2/V\text{-}s$	$\mu_n = 300$ $cm^2/V\text{-}s$
$\mu_n = 700$ $cm^2/V\text{-}s$	$\mu_p = 450$ $cm^2/V\text{-}s$

Take $n_i = 1{\cdot}5 \times 10^{10}$ cm^{-3}.

The junction is forward biased by 0·5 V. Find

(i) forward current

(ii) current at a reverse bias of − 0·5 V. *20*

(c) An InGaAs pin photodiode has the following parameters at a wavelength of 1300 nm :

$$I_D = 4 \text{ nA}; \eta = 0{\cdot}90; R_L = 1 \text{ k}\Omega; P_{in} = 300 \text{ nW}$$

where P_{in} is incident optical power. The receiver bandwidth is 20 MHz. Assume surface leakage current is negligible.

Determine

(i) mean-square shot noise current,

(ii) mean-square dark current and

(iii) mean-square thermal noise current.

Which noise is more severe and why ? *20*

Q3. (a) The entry point and exit point of X-rays on a power pattern taken from a cubic crystal material could not be distinguished. Assuming one of the points to be the exit point, the following S values were obtained :

S values : 311·95 mm, 319·10 mm and 335·05 mm.

The camera radius is 57·3 mm and Molybdenum K_α radiation of wavelength 0·7 Å was used.

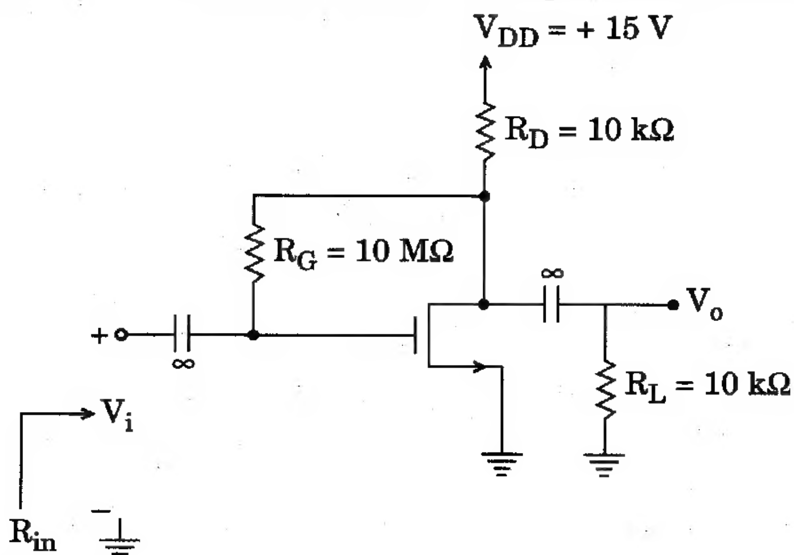
Determine the structure and the lattice parameter of the material. *20*

(b) (i) Obtain the exact equivalent circuit (per phase) of three-phase induction motor. *10*

(ii) A 6-pole, 3-phase, 50 Hz induction motor takes 50 kW power at 940 rpm. The stator copper loss is 1·4 kW, stator core loss is 1·6 kW, and rotor mechanical losses are 1 kW. Find the motor efficiency. *10*

(c) An industrial consumer is operating a 50 kW induction motor at a lagging p.f. of 0·8. The source voltage is 230 V rms. In order to obtain lower electrical rates, the customer wishes to raise the p.f. to 0·95 lagging. Specify a suitable solution. *20*

Q4. (a) Figure below shows a discrete MOSFET amplifier utilizing a drain-to-gate resistance R_G. The input signal V_i is coupled to the gate via a large capacitor, and the output signal at the drain is coupled to load resistance R_L via another large capacitor. Analyze this amplifier circuit to determine its small signal voltage gain, its input resistance, and the largest allowable input signal. Assume $V_t = 1{\cdot}5$ V, K'_n (W/L) (process transconductance parameter) = $0{\cdot}25$ mA/V^2, and $V_A = 50$ V, where V_A is the intercept on the V_{DS} axis of the $i_D - V_{DS}$ characteristics when extrapolated. Assume that coupling capacitors are sufficiently large so as to act as short circuit at the frequencies of interest.



The effect of channel length modulation on the dc operating point can be neglected. *20*

(b) (i) Define nanomaterials and classify nanomaterials on the basis of number of dimensions. What are the different approaches for the preparation of nanomaterials ? Discuss any one method of preparation of nanomaterials from each approach. *10*

(ii) Explain how dislocation density increases on cold working. *10*

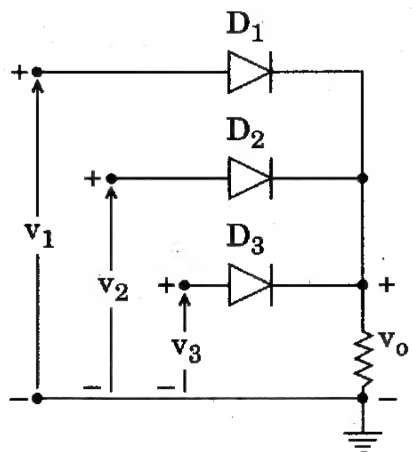
(c) (i) The Burgers vector of a mixed dislocation line is $\frac{1}{2}\,[1\ \ 1\ \ 0]$. The dislocation line lies along the $[1\ \ 1\ \ 2]$ direction. Find the slip plane on which this dislocation lies. *10*

(ii) Explain, why end centered tetragonal geometry does not exist. *10*

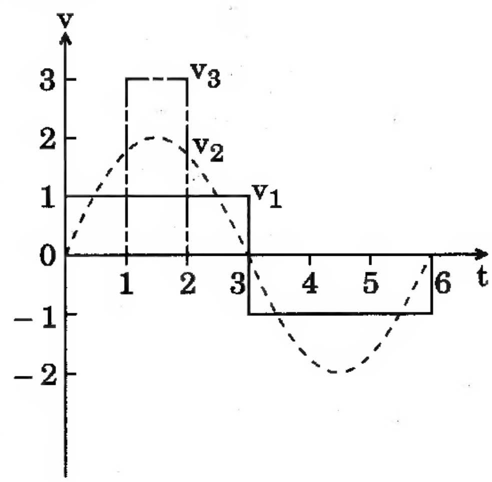
SECTION B

Q5. (a) (i) Sketch the circuit of a one-shot using a 555 timer to provide one time period of 20 μs. If $R_A = 7 \cdot 5$ kΩ, what value of C is needed ? Also sketch the input and output waveforms, when triggered by a 10 kHz clock for $R_A = 5 \cdot 1$ kΩ and C = 5 nF. *6*

(ii) The logic OR gate can be used to fabricate composite waveforms. Sketch the output v_o of the gate of figure (a) shown below if the three signals as shown below in (b) are impressed on the input terminals. Assume the diodes are ideal. *6*

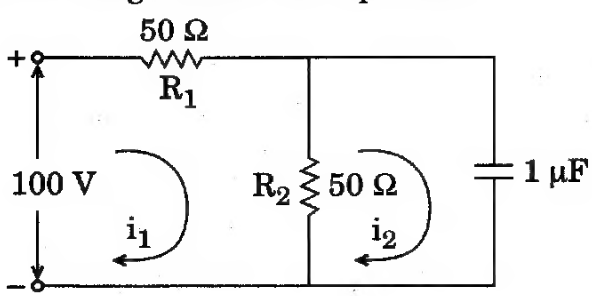


(a)



(b)

(b) A dc voltage of 100 V is suddenly applied in the network shown in the figure. Find the transient currents in both the loops and obtain the transient voltage across the capacitor. *12*



(c) Predict and draw the crystal structure of MgO and compute its theoretical density. (Give Ionic radius of Mg^{++} ion, $r_{Mg^{++}} = 0 \cdot 72$ Å and ionic radius of O^{--} ion, $r_{O^{--}} = 1 \cdot 40$ Å; atomic masses of 'Mg' and 'O' are 24·31 g/mol and 16·00 g/mol, respectively, Avogadro's Number = $6 \cdot 023 \times 10^{23}$ g/mol) *12*

(d) A digital ramp A/D converter has the following values :

Clock frequency, $f_c = 1$ MHz

Threshold voltage, $V_T = 100\ \mu V$

D/A-$V_{ref.}$ = 10·24 V and Number of input bits = 10

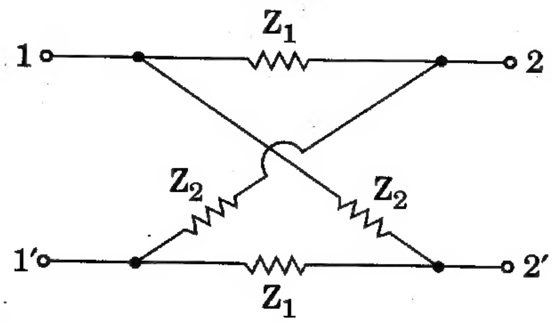
Determine :

(i) Digital/equivalent representation for $V_{in} = 4{\cdot}872$ V

(ii) Resolution of the A/D converter and

(iii) Conversion time required by this digital ramp A/D converter. *12*

(e) For the lattice two port network of the figure shown, find the image impedance and the image transfer constant. *12*



Q6. (a) A first-order thermometer was dipped in a temperature-controlled water bath maintained at 100°C and the following time-temperature readings were obtained :

Time (s)	0	4	8	12	16	20
Temperature (°C)	15	50	70	85	90	95

Estimate the time constant of the thermometer. Determine the steady state error when the thermometer is required to measure the temperature of a liquid which is being heated at a constant rate of 0·1°C/s . *20*

(b) A quartz Piezoelectric Transducer (PZT) has the following specifications : Area = 1 cm^2; Thickness = 2 mm; Young's modulus = 9×10^{10} Pa; Charge sensitivity = 2 pC/N; Relative permittivity = 5 and Resistivity = 10^{12} Ω-cm. A 10 pF capacitor and a 100 MΩ resistor are connected in parallel across the electrodes of the PZT. If a force $F = 0{\cdot}02 \sin (10^3\, t)$ N is applied, determine

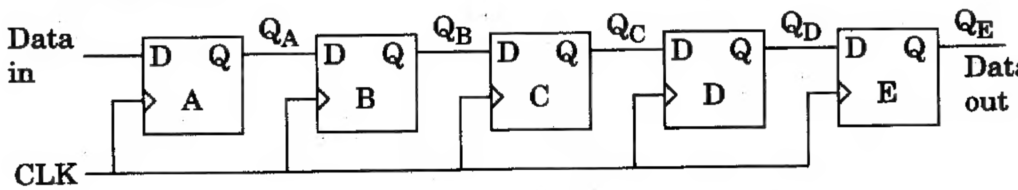
(i) the peak-to-peak voltage generated across the electrodes and

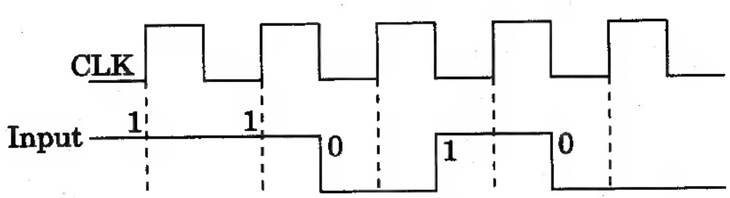
(ii) the maximum change in crystal thickness. *20*

(c) (i) Generate the logic function given in the table below using IC74151 8-to-1 MUX. *10*

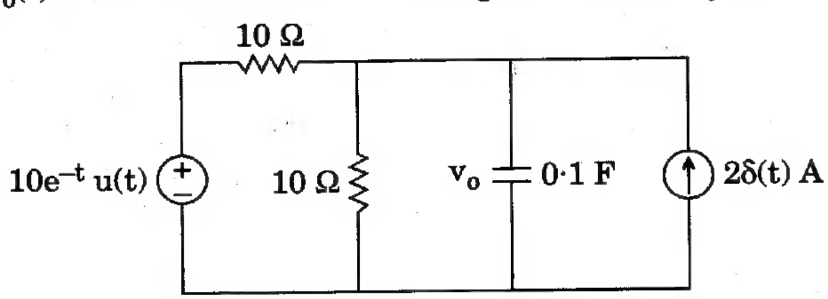
Inputs			Output
C	B	A	Y
0	0	0	0
0	0	1	1
0	1	0	1
0	1	1	0
1	0	0	0
1	0	1	0
1	1	0	0
1	1	1	1

(ii) Show the states of the five-bit register shown below using waveforms, for the specified data input and clock signal. Assume the registers to be initially cleared (all 0s). How long will it take to shift an 8-bit number into a shift register if the clock is set to 10 MHz ? *10*





Q7. (a) Find $v_o(t)$ in the circuit shown in the figure. Assume $v_o(0) = 5$ V. *20*



(b) (i) In a cathode-ray tube, the electron beam is displaced vertically by a magnetic field of flux density 2×10^{-4} Wb/m^2. The length of the magnetic field along the tube axis is same as that of electrostatic deflection plates. The final anode voltage is 1 kV. Determine the voltage which should be applied to the y-deflection plates 10 mm apart to return the spot back to the centre of the screen. Take

Mass of electron = $9{\cdot}107 \times 10^{-31}$ kg and

Charge on electron = $1{\cdot}6 \times 10^{-19}$ C. *10*

(ii) A moving coil milli-ammeter having a resistance of 20 Ω gives full scale deflection when a current of 10 mA is passed through it. Describe how this instrument can be used for measurement of

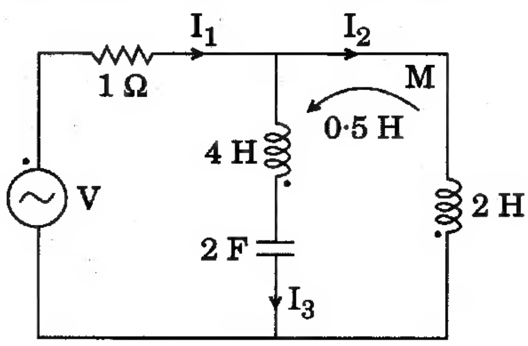
Current up to 1A and

Voltage up to 5 V. *10*

(c) (i) Draw the oriented graph of a network with fundamental cutset matrix as shown below : *10*

Twigs				Links		
1	2	3	4	5	6	7
1	0	0	0	–1	0	0
0	1	0	0	1	0	1
0	0	1	0	0	1	1
0	0	0	1	0	1	0

(ii) For the network shown in the figure, draw the oriented graph, obtain the cutset matrix and find the number of links. *10*



Q8. (a) (i) For the network in the figure shown below, determine

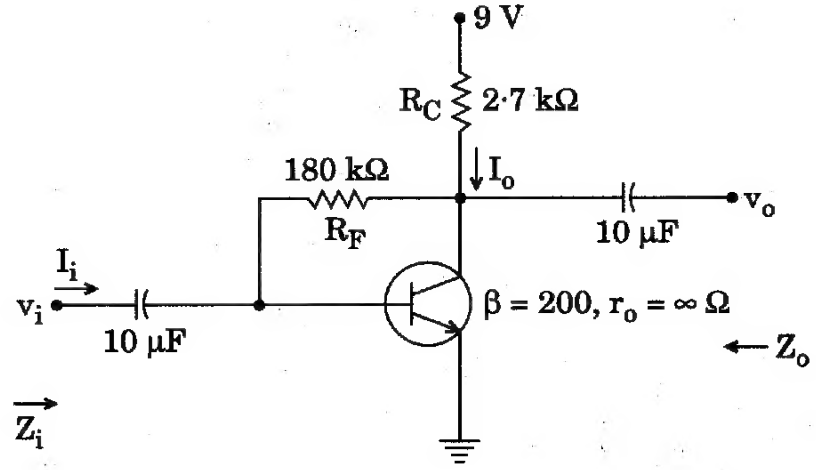
I. r_e

II. Z_i

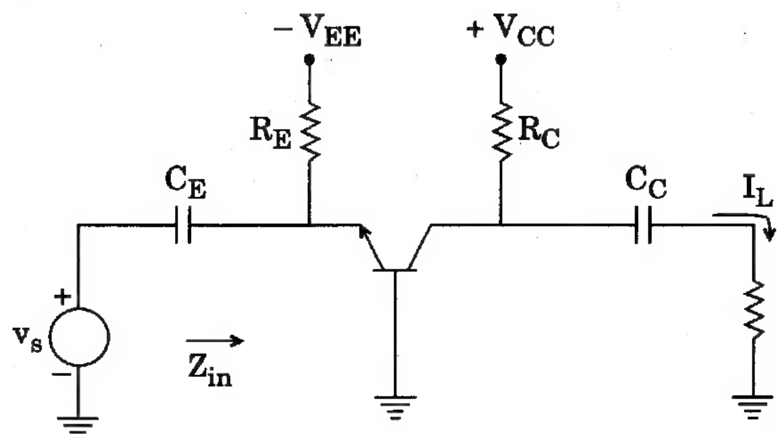
III. Z_o

IV A_v

Repeat parts II, III and IV with $r_o = 20\ k\Omega$ and compare results. *10*



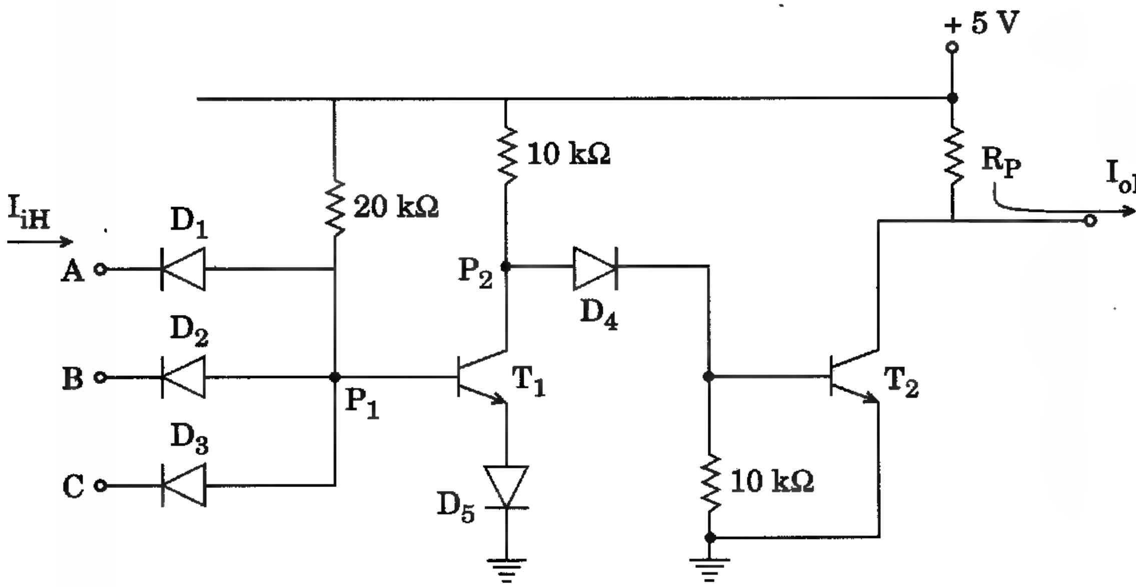
(ii) Draw the equivalent circuit (hybrid-π high frequency model) of the CB amplifier shown below. Find an expression for the high-frequency voltage-gain ratio. Also describe the high-frequency behaviour of this amplifier. *10*



(b) Find [z] and [g] of a two-port network if $[T] = \begin{bmatrix} 10 & 1{\cdot}5\ \Omega \\ 2s & 4 \end{bmatrix}$. *20*

(c) For the circuit shown below, identify the logic function performed by it. Also determine the high level fan-out, if R_P (pull-up resistor) = 10 kΩ. Compute the maximum value of R_P for a fan-out of 5. Assume that input diode has a leakage current of 100 μA.

Given : $V_T = 0{\cdot}7$ V, V_D (forward voltage drop) = 0·8 V, V_{BE}(cut-in) = 0·5 V, V_{CE}(sat) = 0·2 V. Transistor leakage current is negligible. *20*



Engineering ... Exam 2020 Engineering S... Exam 2020

ELECTRONICS AND TELECOMMUNICATION ENGINEERING

Paper – II

Time Allowed : Three Hours

Maximum Marks : 300

Question Paper Specific Instructions

Please read each of the following instructions carefully before attempting questions :

*There are **EIGHT** questions divided in **TWO** sections.*

*Candidate has to attempt **FIVE** questions in all.*

*Questions No. **1** and **5** are **compulsory** and out of the remaining, any **THREE** are to be attempted choosing at least **ONE** question from each section.*

The number of marks carried by a question / part is indicated against it.

Wherever any assumptions are made for answering a question, they must be clearly indicated.

Diagrams / figures, wherever required, shall be drawn in the space provided for answering the question itself.

Unless otherwise mentioned, symbols and notations have their usual standard meanings.

Attempts of questions shall be counted in sequential order. Unless struck off, attempt of a question shall be counted even if attempted partly.

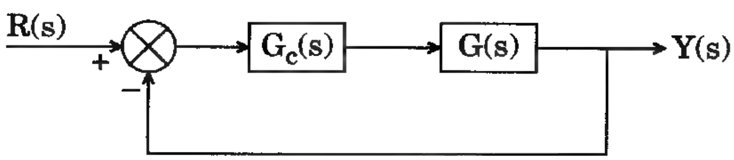
Any page or portion of the page left blank in the Question-cum-Answer Booklet must be clearly struck off.

*Answers must be written in **ENGLISH** only.*

SECTION A

Q1. (a) A certain speech signal is sampled at 8 kHz and coded with DPCM, the output of which belongs to a set of 8 symbols $s_1 - s_8$.
The probabilities of these symbols are $p(s_1) = 0{\cdot}4$, $p(s_2) = p(s_3) = 0{\cdot}2$, $p(s_4) = 0{\cdot}1$, $p(s_5) = 0{\cdot}05$, $p(s_6) = p(s_7) = 0{\cdot}02$ and $p(s_8) = 0{\cdot}01$. Calculate the entropy in bits/sec. If all the symbols are equiprobable, what will be the entropy ? *10*

(b) In the figure shown below, $G(s) = \dfrac{K}{(\tau s + 1)}$ has a time constant of 0·5 seconds, and has unity DC gain. An integral controller is placed in forward path as $G_c(s) = \dfrac{K_1}{s}$ such that the open loop transfer function $G(s)\, G_c(s)$ has a velocity error constant $K_V = 1$. Find the sensitivity of the closed loop system transfer function with respect to K_1 at $\omega = 1$ rad/sec. *10*



(c) List and define various scheduling performance criteria used for comparing various CPU-scheduling algorithms. Compute and compare the average process waiting time of First come First serve, Shortest task first and Priority scheduling algorithms for the processes with their details as listed in the table. *10*

Process	Arrival Time	Burst Time	Priority
P_0	0	3	1
P_1	2	2	2
P_2	3	4	3
P_3	4	7	1

(d) A uniform plane wave is propagating in z-direction with velocity $1{\cdot}4 \times 10^8$ m/s in a perfect dielectric medium of intrinsic impedance 474 Ω. If $E_x(z, t) = 1750 \cos(10^6 \pi t - \beta z)$ V/m represents instantaneous electric field, what will be the magnetic field ? Determine the wavelength and average power of the wave. *10*

(e) Processor technology deals with computation architectures whereas IC technology deals with implementation style for a given functionality. What are the different processor and IC technologies ? Is processor technology orthogonal to IC technology or interdependent with IC technology ? Justify your answer. *10*

(f) Explain the following terms :

(i) Modal Birefringence

(ii) Coherence Length

(iii) Beat Length

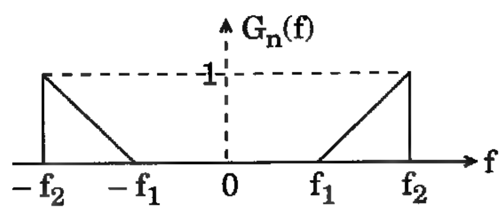
The difference between the propagation constants for the two orthogonal modes in the single mode fiber is 250. It is illuminated with light of peak wavelength 1·55 μm from an injection laser source with a spectral width of 0·8 nm. Calculate Modal Birefringence, Coherence Length and Beat Length. *10*

Q2. (a) Narrow band noise $n(t)$ having bandwidth 2B centered at f_0 is expressed as $n(t) = n_I(t) \cos (2\pi f_0 t) - n_Q(t) \sin (2\pi f_0 t)$, where $n_I(t)$ and $n_Q(t)$ are inphase and quadrature components respectively.

(i) Draw the block diagram of the scheme and show the extraction of $n_I(t)$ and $n_Q(t)$ from $n(t)$. *6*

(ii) If $G_n(f)$ is power spectral density (PSD) of $n(t)$, derive expressions in terms of $G_n(f)$ for PSD of $n_I(t)$ and $n_Q(t)$. *8*

(iii) If $G_n(f)$ is as shown, sketch PSD of $n_I(t)$ assuming $f_0 = f_1$. *6*



(b) For a unity feedback system with $G(s) = \dfrac{3s + \alpha}{s(s+1)(s+5)}$, draw the root locus plot as parameter α varies from 0 to ∞. Also find the value of parameter α for which the closed loop system becomes unstable. From the root locus plot, obtain approximate location of the system poles with $\xi = 0{\cdot}707$. *20*

(c) Memory sub-system for a product has been designed with 3-level memory hierarchy within a budget of ₹ 22,000. The known and unknown parameters for the design are tabulated below :

Memory Type	Access Time	Capacity	Cost per kilobyte in ₹
Cache	5 ns	1 MB	1
Main Memory	–	128 MB	0·1
Solid State Drive (SSD)	5 μs	–	0·001

The design achieved an effective memory access time of 20 ns with cache hit ratio 0·95 and main memory hit ratio 0·99. The SSD can be only in integer powers of 2 in GB.

Find out the missing parameters in the above table. *20*

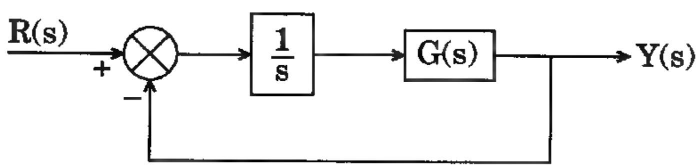
Q3. (a) In a particular AM system, quadrature modulation is used where the inphase carrier modulates $(m_1(t) + V_0)$ and quadrature carrier modulates $m_2(t)$, where $m_1(t)$ and $m_2(t)$ are low pass band-limited message signals and V_0 is constant.

(i) Write the expression for quadrature AM signal. *4*

(ii) Assuming V_0 is large, show that $m_1(t)$ can be recovered using envelope detector. *8*

(iii) Propose a coherent demodulation scheme and show the recovery of $m_2(t)$. *8*

(b) For the unity feedback system shown in the figure, the plant G(s) has a step response of $(3 - 6e^{-2t} + 3e^{-4t})\, u(t)$ and it is placed in cascade with a block of gain $\frac{1}{s}$. Sketch the Nyquist plot of the system and find its gain and phase margins. Also comment whether the closed loop system is stable or not. *20*



(c) Design a 4-bit arithmetic circuit with one selection variable s and two four-bit data inputs A and B. The circuit generates the following four arithmetic operations in conjunction with the input carry C_{in}. Draw the logic diagram for the following : *20*

S	$C_{in} = 0$	$C_{in} = 1$
0	D = A + B	D = A – B
1	D = A + 1	D = A – 1

Q4. (a) Twelve different audio signals each band-limited to 10 kHz are to be multiplexed and transmitted.

(i) TDM is used with flat top samples of 1 μsec duration and with provision of one extra pulse of 1 μsec duration for synchronisation. If sampling is at Nyquist rate, calculate the spacing between successive samples of TDM signal. What is the bandwidth of this TDM signal ? *12*

(ii) If the audio signals are multiplexed using FDM and transmitted using AM – SSB, what is the minimum bandwidth required ? *8*

(b) Given a system with transfer function $G(s) = \frac{10}{(s+1)(s+4)}$, find its equivalent state space phase variable canonical representation in the form $\dot{x} = Ax + Bu$, $y = Cx + Du$. Also design a state feedback controller $u = Kx$ such that the system admits a peak response $M_{pw} = 1{\cdot}25$ in frequency domain and a peak time $t_p = 3{\cdot}53$ seconds in time step response. *20*

(c) Following Register Transfer statements provide the operations to be performed with flip-flop F :

$$X_1T_1 : F \leftarrow 0$$
$$X_2T_2 : F \leftarrow 1$$
$$X_3T_3 : F \leftarrow G$$
$$X_4T_4 : F \leftarrow \bar{F}$$

In all other conditions, the contents of F do not change. Using J-K flip-flops, draw the logic diagram showing connections of the gates that implement control function for F. *20*

SECTION B

Q5. (a) Band-limited message signal m(t) is encoded using PCM system which uses uniform quantizer and 8-bit binary encoding. If the bit rate is 56 Mb/sec, what is the maximum bandwidth of m(t) for satisfactory operation ?

Calculate signal to quantization noise ratio if m(t) is full load single tone sinusoidal signal of frequency 1 MHz. *10*

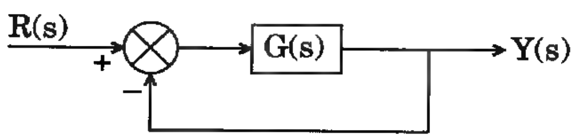
(b) For a unity feedback system shown in the figure, $G(s) = \frac{K}{s(s+\alpha)}$ has resonant frequency 'ω_r' which is $\frac{1}{\sqrt{2}}$ times the damped frequency 'ω_d'. G(s) also has a setting time of $2\sqrt{3}$ seconds, for a 2% tolerance band in its time step response. Calculate the following :

(i) Undamped natural frequency

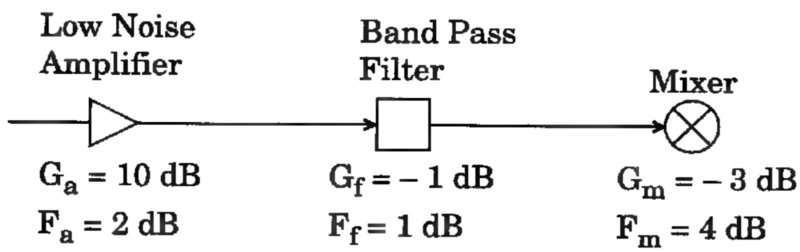
(ii) Decay rate

(iii) Peak overshoot

(iv) Steady state error for the input r(t) = t . u(t) *10*



(c) The block diagram of a wireless receiver front end is shown below :



(i) Compute the overall Noise Figure of the sub-system.

(ii) Compute equivalent noise temperature (overall) assuming system temperature T_0 = 290 K.

(iii) Compute overall gain.

(iv) Compute output noise power assuming input noise power from the feeding antenna at 150 K temperature and 1 F.

(v) Bandwidth of 10 MHz.

(vi) Compute input power if we require minimum signal to noise ratio of 20 dB.

(vii) Compute minimum signal voltage assuming characteristic impedance of 150 Ω. *10*

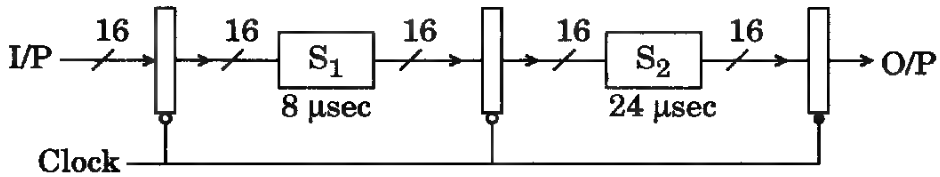
(d) Normalised radiation intensity of an antenna is given by

$$U_n(\theta) = 1, \quad 0 \le \theta < 30^\circ$$
$$= \frac{\cos\theta}{0{\cdot}866}; \; 30^\circ \le \theta < 90^\circ$$
$$= 0; \; 90^\circ \le \theta \le 180^\circ$$

It is independent of Φ.

Determine exact directivity and maximum aperture area at operating frequency of 900 MHz. *10*

(e) The figure shown below indicates a two-stage pipeline with stage delays indicated below the stages. Latch delays are to be ignored.



(i) Calculate throughput and latency of the pipeline shown above. *5*

(ii) The pipeline stage 2 is now split in three equal sub-stages. Find out the new throughput and latency for the complete pipeline. *5*

(f) An isolator has an insertion loss of 0·5 dB and an isolation of 30 dB. Determine the scattering matrix of the isolator if the isolated ports are perfectly matched to the junction. *10*

Q6. (a) Lossless transmission line operating at 30 MHz has inductance L = 1 μH/m and capacitance C = 100 pF/m. Quarter wave transformer line is used to couple this transmission line to different loads for impedance matching.

(i) Calculate the characteristic resistance of the quarter wave line if load is an antenna offering pure resistance of 70 Ω. *8*

(ii) If load is Z_L = 150 + j100 Ω, determine the characteristic resistance of the quarter wave line. *12*

(b) Consider a CMOS schematic for 2-input NOR gate.

Design appropriate test scheme to check the following faults through control/observation of voltage/current levels at Input/Output/supply.

(i) One pMOS transistor stuck open *10*

(ii) One nMOS transistor stuck short *10*

(c) Write the expression for signal to noise ratio for PIN diode. A silicon PIN photodiode incorporated into the optical receiver has a quantum efficiency of 65% when operating at wavelength of 0·9 μM. The dark current at this point is 3 nA and load resistance is 4 kΩ. The post detection bandwidth of the receiver is 5 MHz and the thermal noise temperature is 20°C. If the overall signal to noise ratio is 5 dB, calculate the incident power. *20*

Q7. (a) A coaxial capacitor of length 1 m is formed using two concentric cylindrical conductors. The inner conductor has radius 4 mm and the outer conductor radius is 16 mm. The space between them is filled with 3 layers of perfect dielectric materials with different dielectric constants such that $\varepsilon_{r_1} = 5$, 4 mm < ρ < 8 mm; $\varepsilon_{r_2} = 3$, 8 mm < ρ < 12 mm and $\varepsilon_{r_3} = 1$, 12 mm < ρ < 16 mm. If the potential difference between the inner and outer conductor is 100 V, determine the capacitance and charge on the inner conductor. ($\varepsilon_0 = 8{\cdot}854 \times 10^{-12}$ F/m) *20*

(b) (i) The impulse response of an LTI system is given by

$$h(n) = \left[\left(\frac{1}{4}\right)^n \cos\left(\frac{\pi}{4}n\right)\right]u(n)$$

Realize this system using finite number of adders, multipliers and minimum possible unit delays. *10*

(ii) Consider an initially relaxed system whose output y(n) for $n \geq 0$ is the Fibonacci series. Describe this system in the form of difference equation relating input and output. Obtain impulse response of this system. *10*

(c) A hexagonal cell within a four cell system has a radius of 1·387 km. A total of 60 channels are used in the entire system. If the load per user is 0·029 Erlangs and λ = 1 call/hour, compute the following for an Erlang C system that has 5% probability of a delayed call :

(i) How many users per square km will this system support ?

(ii) What is the probability that a delayed call will have to wait for more than 10 s ?

(iii) What is the probability that a call will be delayed for more than 10 s ?

Erlang C Traffic Table

Maximum offered load versus B and N *20*

N \ B	1	2	5	10	15
14	6·70	7·31	8·27	9·15	9·76
15	7·39	8·03	9·04	9·97	10·60
16	8·09	8·76	9·82	10·79	11·44

Q8. (a) Consider an air filled rectangular waveguide with inner dimension of width and height a and b respectively (a > b).

(i) With clear reasoning describe why propagation is not possible if both electric and magnetic fields in the direction of propagation are zero. *6*

(ii) The propagation constant γ for TE and TM mode is given by

$$\gamma^2 = \left(\frac{m\pi}{a}\right)^2 + \left(\frac{n\pi}{b}\right)^2 - \omega^2 \mu \varepsilon$$

where m and n are integers.

Obtain an expression for minimum frequency below which propagation is not possible. *6*

(iii) If a = 2 cm and b = 1 cm, determine the range of frequency at which only one mode propagates. ($\varepsilon = 8{\cdot}854 \times 10^{-12}$ F/m, $\mu_0 = 4\pi \times 10^{-7}$ H/m) *8*

(b) A display is connected to port P1 of 8051 microcontroller. A sequence of 7-bit-patterns are to be displayed in cyclic manner continuously. Write a program in 8051 assembly to display the bit-patterns (8-bit each) with a delay of 1 second between each pair of bit-patterns. The bit-patterns are stored in program memory space at the start at location 400H. Assume that sub-routine for delay is available directly. Comment on your program appropriately and mention any necessary assumptions explicitly. *20*

(c) The dominant mode TE_{10} is propagated in a rectangular waveguide of dimensions a = 6 cm and b = 4 cm. The distance between maximum and minimum is found to be equal to 4·47 cm with the help of travelling wave detector. Determine the signal frequency. *20*

Engineering Service
(Main) Exam,2021

U-ELX-YUGT

ELECTRONICS AND TELECOMMUNICATION ENGINEERING

Paper – I

*Time Allowed : **Three Hours***

*Maximum Marks : **300***

Question Paper Specific Instructions

Please read each of the following instructions carefully before attempting questions :

*There are **EIGHT** questions divided in **TWO** sections.*

*Candidate has to attempt **FIVE** questions in all.*

*Questions No. **1** and **5** are **compulsory** and out of the remaining, **THREE** are to be attempted choosing at least **ONE** question from each section.*

The number of marks carried by a question / part is indicated against it.

Wherever any assumptions are made for answering a question, they must be clearly indicated.

Diagrams / figures, wherever required, shall be drawn in the space provided for answering the question itself.

Unless otherwise mentioned, symbols and notations carry their usual standard meanings.

Attempts of questions shall be counted in sequential order. Unless struck off, attempt of a question shall be counted even if attempted partly.

Any page or portion of the page left blank in the Question-cum-Answer Booklet (QCA) must be clearly struck off.

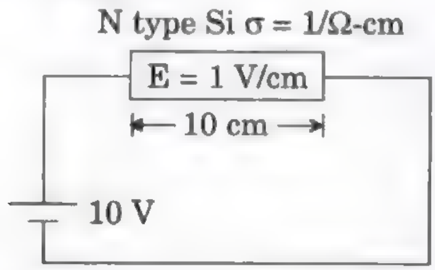
*Answers must be written in **ENGLISH** only.*

Values of constants which may be required :

Electron charge	=	$-1{\cdot}6 \times 10^{-19}$ Coulomb
Free space permeability	=	$4\pi \times 10^{-7}$ Henry/m
Free space permittivity	=	$(1/36\pi) \times 10^{-9}$ Farad/m
Velocity of light in free space	=	3×10^{8} m/sec
Boltzmann constant	=	$1{\cdot}38 \times 10^{-23}$ J/K
Planck's constant	=	$6{\cdot}626 \times 10^{-34}$ J-s

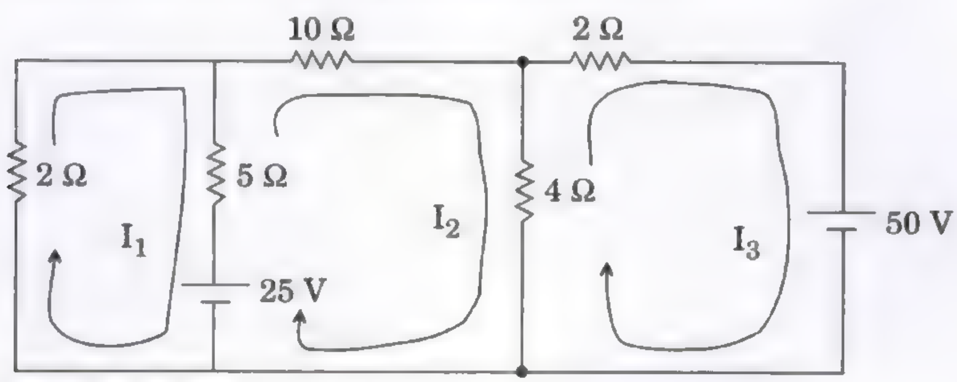
SECTION A

Q1. (a) An N-type silicon bar of conductivity $\sigma = 1/\Omega$-cm has a battery applied across it as shown in the figure below. Assume a hypothetical situation in which the battery is able to sweep some electrons into a region of length 0·03 cm in the middle of the bar, thereby locally increasing the electron density in the region by 1% of the thermal equilibrium density. Make the rough calculation of the order of magnitude of the electric field which will develop there due to this increase in majority carrier density.
Assume, mobility of electron $\mu_n = 1350$ cm^2/V-s,
Permittivity of Si $\varepsilon_{Si} = 10^{-12}$ F/cm. *12*

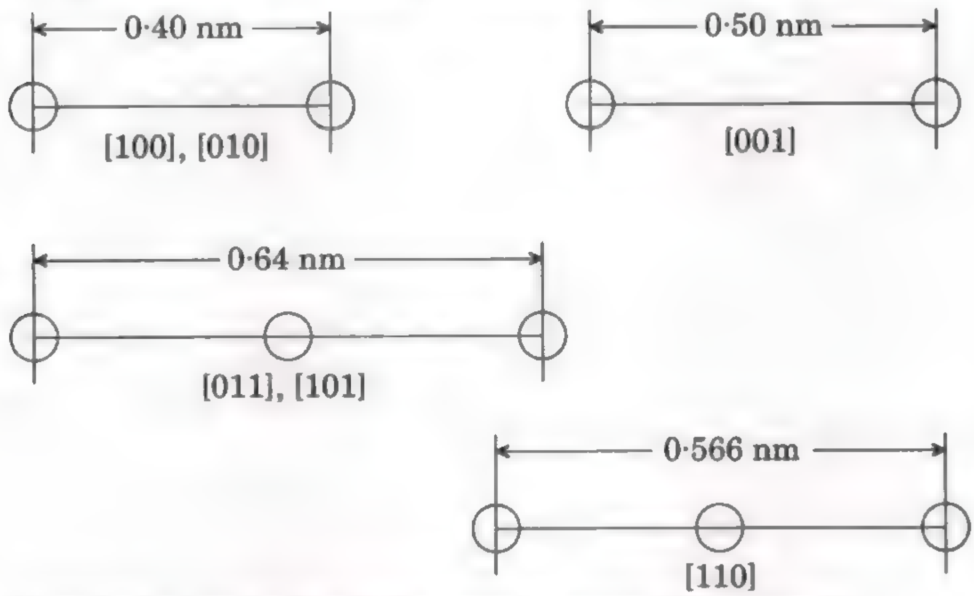


(b) The work function ϕ_m of platinum is 5 eV and the electron affinity for silicon is $\chi_{Si} = 4{\cdot}05$ eV. Determine the barrier height ϕ_{Bn} (barrier height for transfer of electron from metal to semiconductor) and ϕ_{BP} (barrier height for transfer) of holes from metal to semiconductor). Also calculate the built-in voltage V_{bi} for metal-semiconductor contact of platinum with N-type silicon having doping concentration $N_D = 2{\cdot}8 \times 10^{14}/\text{cm}^3$. Assume that effective density of states in the conduction band edge is $N_C = 2{\cdot}8 \times 10^{19}/\text{cm}^3$, KT = 0·025 eV at room temperature, $E_G = 1{\cdot}1$ eV. *12*

(c) Write the mesh current matrix equation for the network of figures shown by inspection, and solve for the currents. *12*



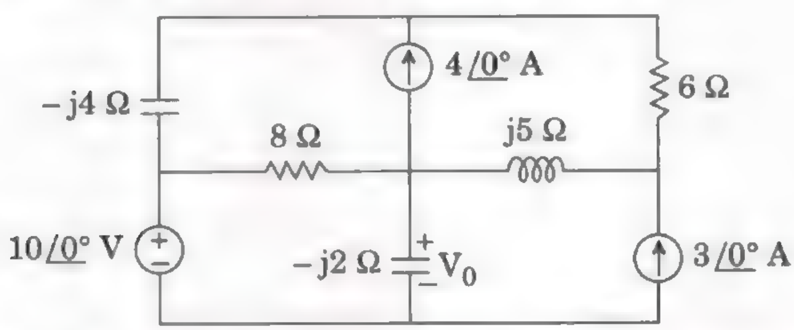
(d) The atomic packing schemes for some hypothetical material for several different crystallographic directions are shown. For each direction the circles represents only those atoms contained within a unit cell, where circles are reduced from their actual diameter/size.



Identify the unit cell and the crystal system it belongs to. *12*

(e) What are the different types of batteries ? How is the right battery selected for an application ? *12*

Q2. (a) Solve for V_0 in the circuit shown in the figure. *20*



(b) An MOS capacitor having the gate oxide thickness, $t_{ox} = 0{\cdot}1\ \mu m$ and substrate boron doping density $N_A = 10^{15}/cm^3$ is biased in the depletion mode with a gate voltage, V_G. If the surface potential is 0·2 V for this bias condition, determine the following : *5×4=20*

(i) Peak electric in silicon substrate

(ii) Electric field in the oxide

(iii) The gate voltage V_G

(iv) Thermal equilibrium hole concentration, p_p and the hole concentration, p_s at the silicon surface.

Note that $\varepsilon_0 = 8{\cdot}854 \times 10^{-14}$ F/cm, $\varepsilon_s = 12$ for silicon and $\varepsilon_{ox} = 4$ for SiO_2.

(c) (i) A silicon P-N junction photodiode has a uniform area of cross-section of $A = 0{\cdot}04\ cm^2$.

In the p-region, $N_A = p_p = 1{\cdot}5 \times 10^{15}/cm^3$ and

in the N-region, $N_D = n_n = 1{\cdot}5 \times 10^{13}/cm^3$.

The intrinsic carrier density in silicon is $n_i = 1{\cdot}5 \times 10^{10}/cm^3$. The diffusion constant for electrons and holes are $D_n = 35\ cm^2/s$ and $D_p = 12{\cdot}5\ cm^2/s$. Holes lifetime in the N-region is $\tau_p = 100\ \mu$ sec and electron lifetime in the p-region is $\tau_n = 35\ \mu$ sec. Assuming that light of a suitable mixture of wavelength falls on the diode producing an idealized generation of EHP, $G_L = 10^{16}$ pairs/sec/cm^2 uniformly at all points within the volume of diode, and the diode is kept short circuited, calculate the light induced current through the photodiode. *15*

(ii) In the photodiode of Q2(c)(i), if instead of short circuiting, the diode is kept open circuited, calculate the open circuit photo voltage, V_{oc} across the diode. Assume $V_T = 0{\cdot}026$ V at room temperature. *5*

Q3. (a) (i) Explain, how Burgers vector is invariant of the type of dislocation. *10*

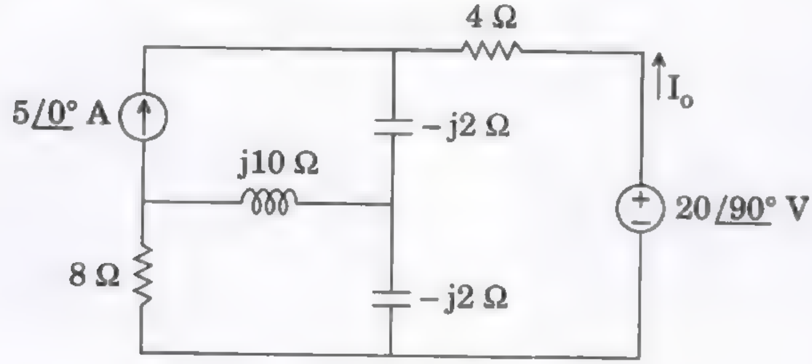
(ii) Out of (100) and (110) crystallographic planes, which plane will have more surface energy for copper single crystal ? *10*

Given : Bond energy per bond for copper = 65·4 kJ/mol

Lattice parameter for copper = 3·61 Å

Avogadro's number = $6{\cdot}023 \times 10^{23}$ g/mol

(b) Use the superposition theorem to find I_o in the circuit shown in the figure. *20*



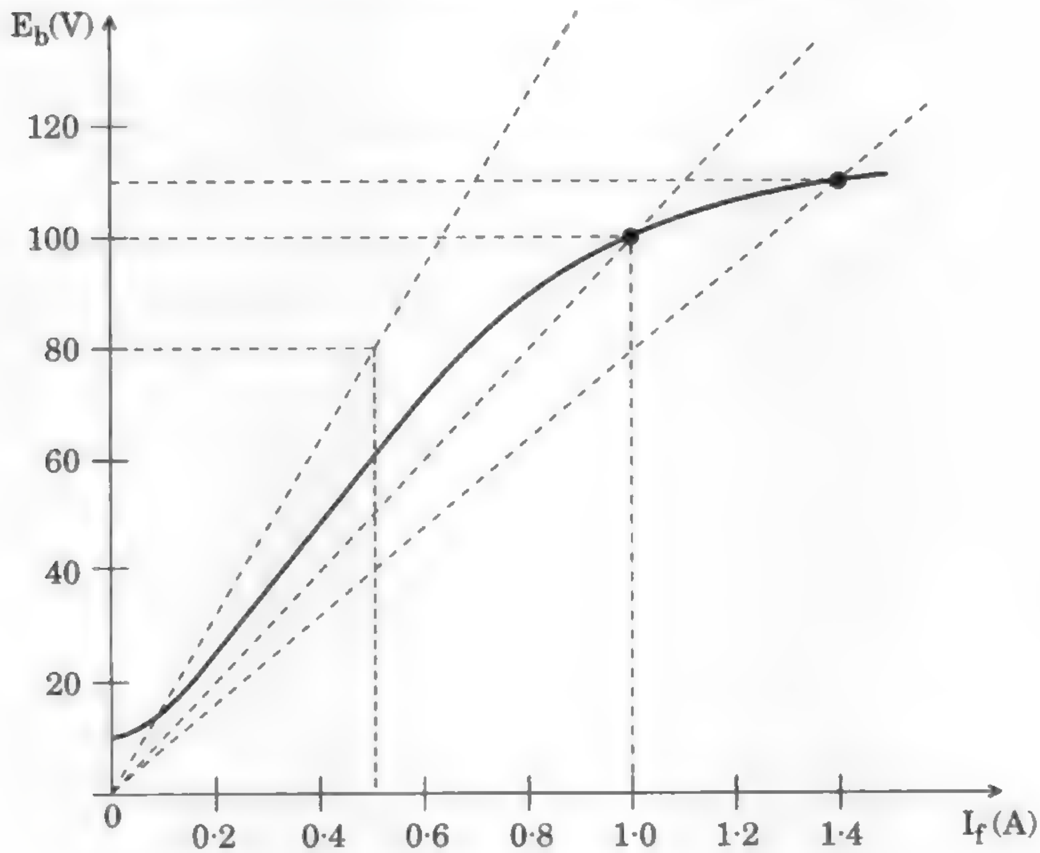
(c) A separately excited DC generator is characterized by the magnetization curve of the figure shown below.

(i) If the prime mover is driving the generator at 800 rev/min, what is the no-load terminal voltage, V_a ?

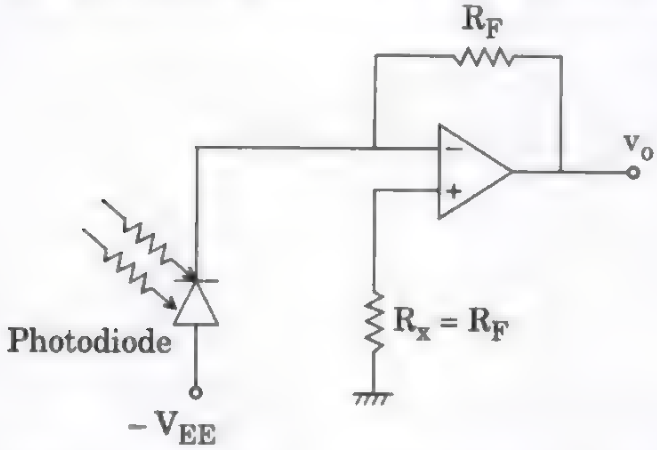
(ii) If a 1-Ω load is connected to the generator, what is the generated voltage ? *20*

Generator ratings : 100 V, 100 A, 1000 rev/min

Circuit parameters : $R_a = 0 \cdot 14\ \Omega$, $V_f = 100$ V, $R_f = 100\ \Omega$



Q4. (a) (i) Design a photo detector circuit of the form as shown in the figure below to give an output voltage of $v_o = -200$ mV at an incident power density of $D_P = 500$ nW/cm^2. The current responsitivity of the photodiode is $D_i = 1$ A/W, and the active area is $a = 400$ mm^2. *10*



(ii) The measured values of a diode at a junction temperature of 25°C are given by

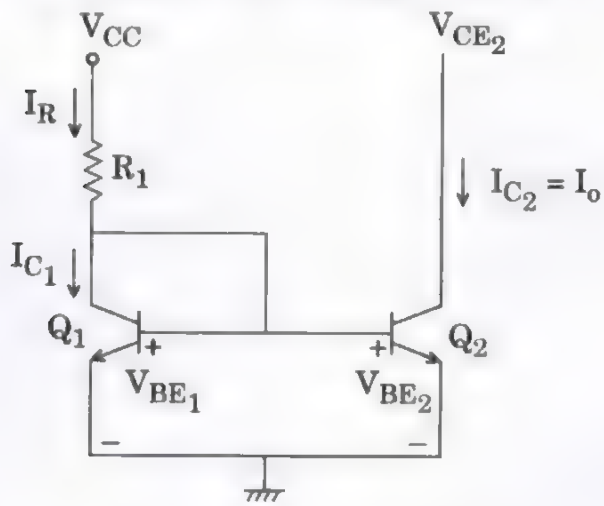
$$V_D = \begin{cases} 0{\cdot}5\ \text{V} & \text{at} \quad I_D = 5\ \mu\text{A} \\ 0{\cdot}6\ \text{V} & \text{at} \quad I_D = 100\ \mu\text{A}. \end{cases}$$

Determine the (I) Emission coefficient η, and (II) the leakage current I_s. Assume $V_T = 25{\cdot}8$ mV. *10*

(b) (i) (I) Design the basic current source shown in the figure below to give an output current, $I_o = 5\ \mu$A.

(II) For Q4(b)(i)(I) calculate the output resistance R_o, Thevenin's equivalent voltage V_{TH}, and the collector current ratio if $V_{CE_2} = 20$ V. *5×2=10*

The BJT parameters are $\beta_F = 100$, $V_{CC} = 30$ V, $V_{BE_1} = V_{BE_2} = 0{\cdot}7$ V, and the early voltage $V_A = 150$ V.



(ii) Using the phasor approach, determine the current i(t) in a circuit described by the integro-differential equation

$$4i + 8 \int i\,dt - 3 \frac{di}{dt} = 50 \cos (2t + 75°).$$ *10*

(c) (i) Draw a schematic cross-sectional view of a MOSFET transistor. How is the insulating layer fabricated in it and what are the parameters that control the thickness of this layer ? *10*

(ii) Classify magnetic materials; and calculate the saturation magnetization and the saturation flux density for nickel. *10*

Given : Density of nickel = 8·90 g/cm^3

Atomic weight of nickel = 58·71 g/mol

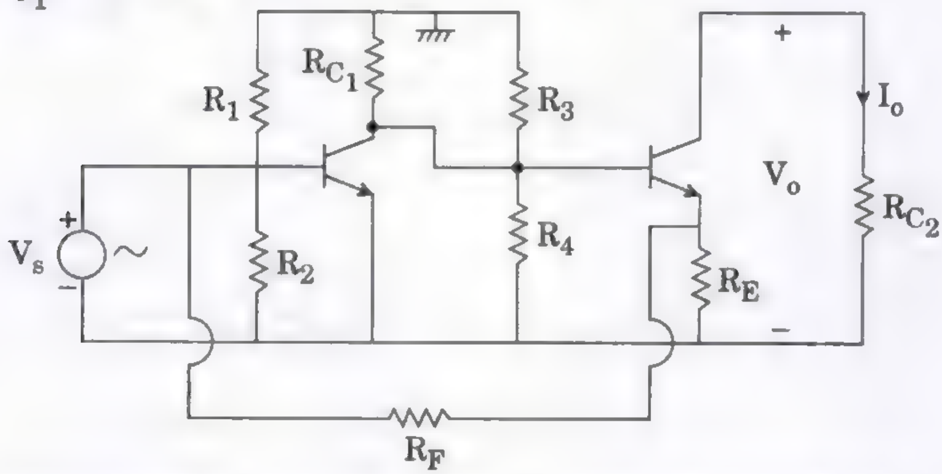
Net magnetic moment per atom for nickel = 0·60 Bohr magneton

Bohr magneton = 9·27 × 10^{-27} A-m^2

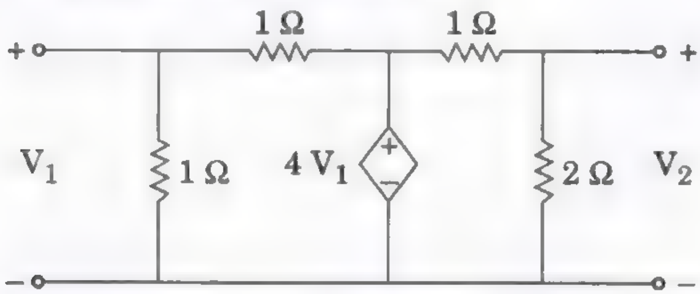
Avogadro's number = 6·023 × 10^{23} g/mol

SECTION B

Q5. (a) The open loop gain of the amplifier shown in the figure below has break frequency at f_{p_1} = 100 kHz, f_{p_2} = 1 MHz and f_{p3} = 10 MHz. The low frequency gain is A_o = 200 A/A and the emitter resistance R_E = 500 Ω. Determine the value of compensating capacitor C_F and resistance R_F to give (i) low frequency closed loop gain of A_f = 20 A/A and cancel the pole f_{p_1} = 100 kHz, and (ii) to add pole of f_p = 10 MHz and cancel the pole f_{p_1} = 100 kHz. *12*



(b) Determine the Z-parameters for the two-port network shown and check for its symmetry and reciprocity. *12*

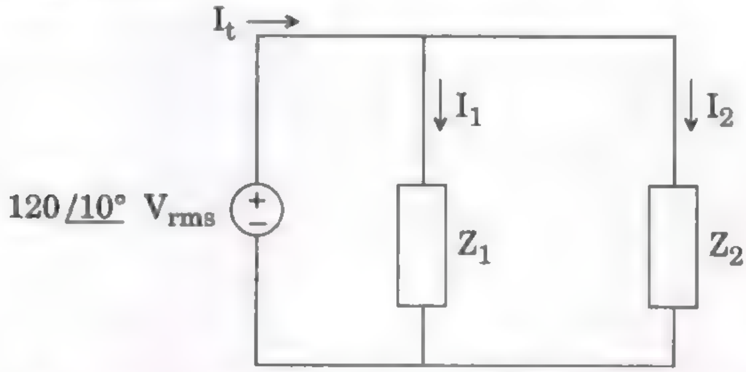


(c) What is superconductivity ? How are the superconducting materials classified ? Give the applications of high temperature superconductors, in brief. *12*

(d) How is the temperature compensation achieved in the measurement of strain ?

The unstrained resistance of each of the four elements of the unbonded strain gauge is 120 Ω. The strain gauge has a gauge factor of 3 and is subjected to a strain of 10^{-4}. If the detector is a high impedance voltmeter, calculate the reading of this voltmeter for a battery voltage of 10 V. Assume the bridge arms A and D are under tension whereas arms B and C are under compression. *12*

(e) In the circuit shown in figure, $Z_1 = 60\angle{-30^\circ}\ \Omega$ and $Z_2 = 40\angle{45^\circ}\ \Omega$. Calculate the total (i) apparent power, (ii) real power, (iii) reactive power, and (iv) P.f. *12*



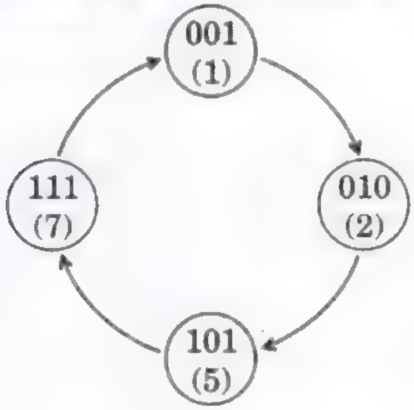
Q6. (a) (i) In a CRT, the anode to cathode voltage is 2 kV. The parallel deflector plates are 1·5 cm long and spaced 5 mm apart. The screen is 50 cm from the centre of the deflecting plates. Find the beam speed and deflection sensitivity of the tube. Mass of electron = $9{\cdot}109 \times 10^{-31}$ kg, Charge on electron = $1{\cdot}602 \times 10^{-19}$ C. *10*

(ii) The coil of a moving iron voltmeter has a resistance of 500 Ω and an inductance of 1·0 H. The series resistor is 2 kΩ. When 250 V dc is applied, the voltmeter reads 250 V. Find the reading when an ac voltage of 250 V, 50 Hz is applied. What is the per cent error ? What capacitance must be connected in parallel with the series resistor to remove this error ? *10*

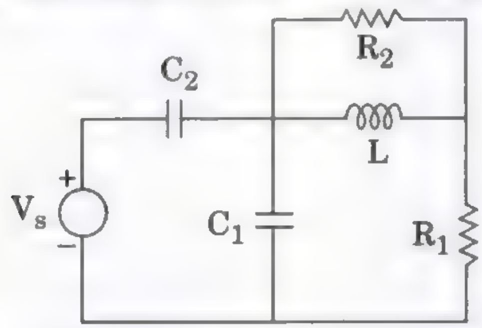
(b) (i) An ac bridge has the following constants :
arm AB, R = 1 kΩ in parallel with C = 0·159 μF;
arm BC, R = 1 kΩ; arm CD, R = 500 Ω; arm DA, C = 0·636 μF in series with an unknown resistor. Find the frequency for which the bridge is in balance and determine the value of resistance in arm DA to produce this balance. *10*

(ii) A dynamometer type wattmeter connected normally to read power in a single phase circuit indicates the value P_1. A second reading P_2 is obtained when a capacitor of reactance equal to the pressure coil resistance is connected in series with pressure coil. Show that the phase angle of the load can be obtained from the expression : $\tan \phi = 1 - \dfrac{2P_2}{P_1}$. *10*

(c) Design a counter with the irregular binary count sequence shown in the state diagram of the following figure. Use J-K flip-flops. *20*



Q7. (a) (i) For the circuit shown, obtain the state equations for $R_1 = R_2 = R$. *12*



(ii) A two-element series circuit is connected across an ac source given by $e(t) = 200\sqrt{2}\ \sin(314\ t + 20°)$. The current in the circuit is found to be $i(t) = 10\sqrt{2}\ \cos(314\ t - 25°)$. Determine the parameters of the circuit. *8*

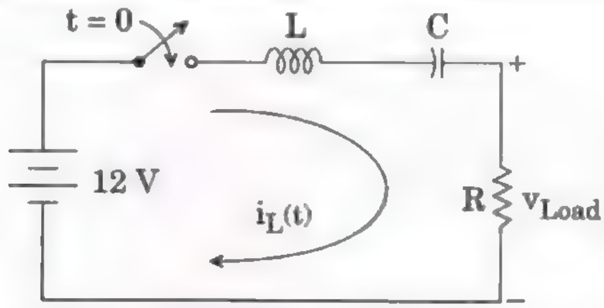
(b) (i) A chromel-constantan thermocouple has its cold junction at 0°C. The characteristics of the thermocouple is :

Temp. °C	0	10	20	30	40	50
emf mV	0	0·593	1·191	1·8	2·415	3·02

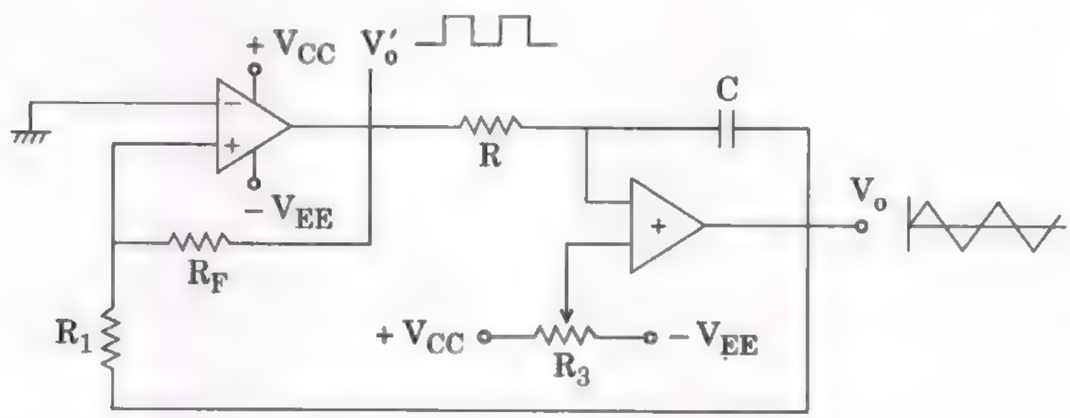
Find the temperature of the hot junction if the thermoelectric emf is 2·95 mV. *10*

(ii) A thermometer, initially at 70°C, is suddenly dipped in a liquid at 300°C. After 3 seconds, the thermometer indicates 200°C. After what time is the thermometer expected to give a reliable reading, say well within 1% of the actual value ? *10*

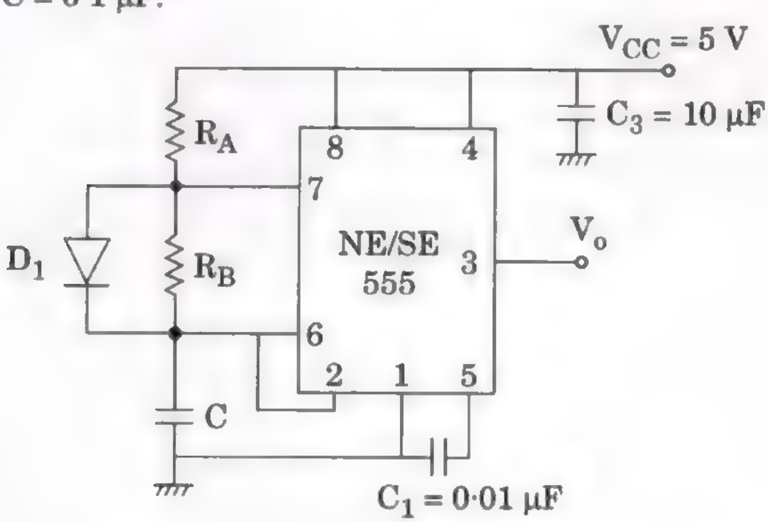
(c) Find the load voltage as a function of time for the circuit shown in the figure. Assume no energy is stored in the capacitor and inductor before the switch closes. Circuit parameters : R = 10 Ω, C = 10 μF, L = 5 mH. *20*



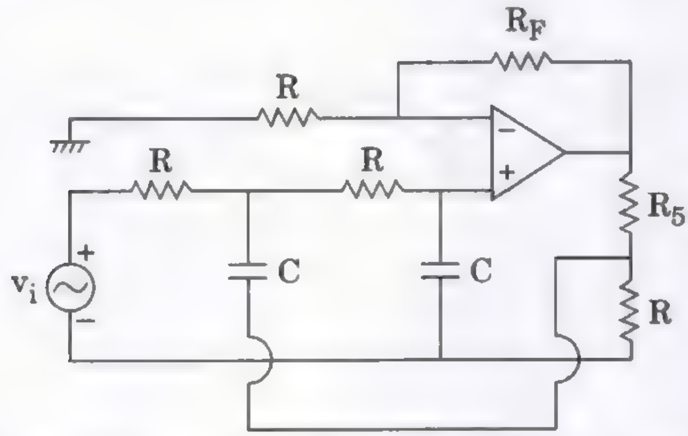
Q8. (a) (i) Design a sawtooth waveform generator shown in the figure below, so that f_o = 4 kHz, threshold voltage V_{TH} = 5 V and the circuit has a duty cycle of 0·25. Assume $V_{sat} = | -V_{sat} |$ = 14 V, and R_1 = 10 kΩ and C = 0·01 μF. *10*



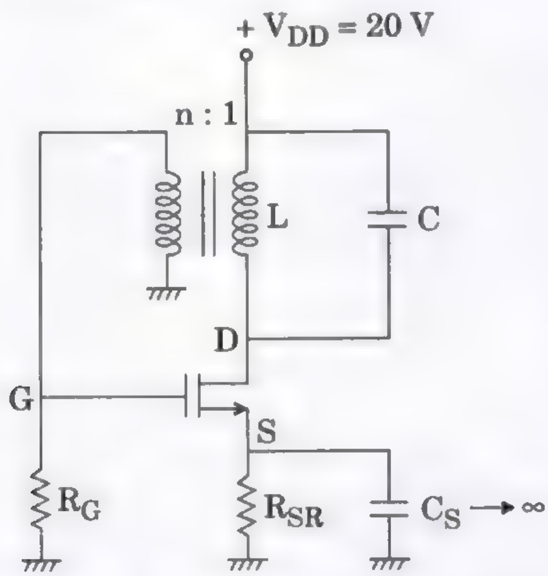
(ii) Design a square wave generator as shown in the figure below, so that duty cycle is 50% and f_o = 2·5 kHz. Assume V_{CC} = 12 V and C = 0·1 μF. *10*



(b) (i) For a second order low pass filter as shown in the figure below, to give a high cutoff frequency of $f_H = f_o = 1$ kHz, a pass band gain $K = 4$, $Q = 0{\cdot}707$ and $C = 0{\cdot}01\ \mu F$. Calculate resistances R, R_F and R_5. *10*



(ii) An LC tuned MOS oscillator is shown in the figure below. Find the value of oscillation frequency and n for $L = 112{\cdot}6\ \mu H$ and $C = 0{\cdot}01\ \mu F$. The parameters of the MOSFET are $g_m = 5$ mA/V, $r_d = 25\ k\Omega$ and $R_G = 10\ k\Omega$. *10*



(c) Draw a 16 × 8-bit ROM array, showing all the inputs and outputs. List the types of read-only memories and explain the differences. *20*

Engineering Service
(Main) Exam,2021

ELECTRONICS AND TELECOMMUNICATION ENGINEERING

Paper – II

*Time Allowed : **Three** Hours*

*Maximum Marks : **300***

Question Paper Specific Instructions

Please read each of the following instructions carefully before attempting questions :

*There are **EIGHT** questions divided in **TWO** sections.*

*Candidate has to attempt **FIVE** questions in all.*

*Questions No. **1** and **5** are **compulsory** and out of the remaining, any **THREE** are to be attempted choosing at least **ONE** question from each section.*

The number of marks carried by a question / part is indicated against it.

Wherever any assumptions are made for answering a question, they must be clearly indicated.

Diagrams / figures, wherever required, shall be drawn in the space provided for answering the question itself.

Unless otherwise mentioned, symbols and notations have their usual standard meanings.

Attempts of questions shall be counted in sequential order. Unless struck off, attempt of a question shall be counted even if attempted partly.

Any page or portion of the page left blank in the Question-cum-Answer Booklet (QCA) must be clearly struck off.

*Answers must be written in **ENGLISH** only.*

SECTION A

Q1. (a) Prove that the random process $x(t, \phi) = \frac{\sqrt{E}}{2T} \cos(\omega_0 t + \phi)$ is ergodic, where E, T and ω_0 are constants, and ϕ is random and UDF $(0, 2\pi)$. *10*

(b) Explain the different masking steps required in the fabrication of a simple NMOS transistor starting from a p-type substrate. *10*

(c) A two-word instruction is stored in memory at an address designated by the symbol A. The address field of the instruction (stored at A + 1) is designated by the symbol B. The operand used during the execution of the instruction is stored at address symbolized by 'C'. An index register contains the value X. State how 'C' is calculated from the other addresses if the addressing mode of the instruction is *10*

(i) Direct

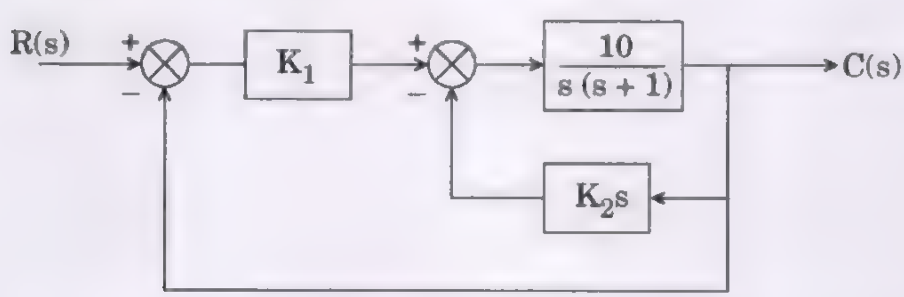
(ii) Indirect

(iii) Relative

(iv) Indexed.

(d) A 75 Ω resistor is connected to a transmission line of characteristic impedance of 50 Ω. Compute the VSWR at the termination. *10*

(e) Compute the values of K_1 and K_2 to obtain a peak time of 1·6 seconds and a settling time of 3·5 seconds for the closed-loop system shown below in response to a step input. *10*



(f) The autocorrelation sequence of a discrete-time stochastic process is $R(K) = \left(\frac{1}{2}\right)^{|K|}$. Determine its Power Spectral Density. *10*

Q2. (a) Let s(t) be a digital NRZ signal (± A), which passes through the noisy channel. Channel introduces white Gaussian Noise ($\omega(t)$) having PSD of $N_0 / 2$. Receiver was designed using Matched Filter, Sample & Hold Circuit and Decision-Making Circuit. Decision-Making Circuit uses maximum likelihood algorithm/technique. Compute the following :

(i) Output of the Sample & Hold Circuit when '– A' is transmitted. *5*

(ii) Variance of the Noisy Signal at the o/p of S & H Circuit. *5*

(iii) Compute the probability of error when '– A' is received/detected as '+ A' and '+ A' is interpreted as '– A'. *10*

(b) The forward path transfer function of a control system with unity feedback is

$$G(s) = \frac{K}{s\,(s + a)\,(s + 30)}$$

where 'a' and 'K' are real constants.

(i) Find the value of 'a' and 'K' so that the relative damping ratio of the complex roots of the characteristic equation is 0·5 and the rise time of the unit step response is approximately 1 sec. *15*

(ii) Find the steady state errors of the system when the reference input is a unit ramp function. *5*

(c) Consider the following set of processes, with the length of the CPU burst given in milliseconds :

Process	Burst Time
P_1	6
P_2	8
P_3	7
P_4	3

(i) Draw the Gantt chart for SJF scheduling. *5*

(ii) What is the waiting time for Process P_1, Process P_2 and Process P_3? *5*

(iii) Calculate the average waiting time. *5*

(iv) Calculate the average waiting time for FCFS scheduling. *5*

Q3. (a) Let there be a transmitter source represented as $[X] = \{x_1, x_2, \dots x_N\}$ having N symbols. Let there be a Receiver having Destination Symbol Vector $[Y] = \{y_1, y_2, y_3, \dots y_M\}$ having 'M' symbols. Transmitted symbols have to pass through channel.

(i) Derive the expression for $I(X, Y)$. *15*

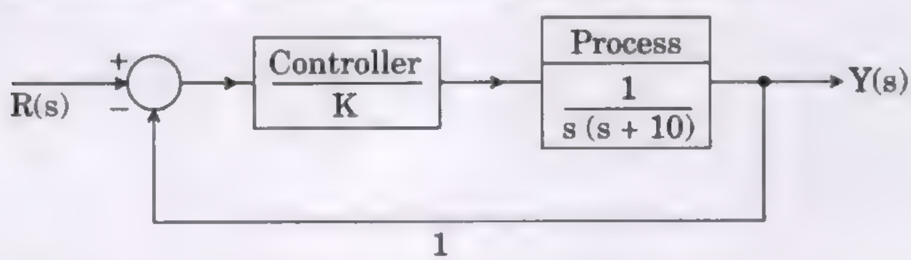
(ii) From the derived expression, compute Max $[I(X, Y)]$ expression. Explain the meaning of terms. *5*

(b) A feedback control system is shown in the following figure. The specification for the closed loop system requires that the overshoot to a step input be less than 15%.

(i) Determine the corresponding specification M_p in the frequency domain for the closed loop transfer function $\frac{Y(j\omega)}{R(j\omega)} = T(j\omega)$. *10*

(ii) Determine the resonant frequency ω_r. *5*

(iii) Determine the bandwidth of the closed loop system. *5*



(c) A digital computer has a memory unit with 28 bits per word. The instruction set consists of 235 different operations. All instructions have an operation code part (op code) and an address part. Each instruction is stored in one word memory.

(i) How many bits are reserved for operation code ? *5*

(ii) How many bits are left for the address part of the instruction ? *5*

(iii) What is the maximum size for the memory ? *5*

(iv) Draw the instruction format and indicate the number of bits in each part. *5*

Q4. (a) Consider the Narrow Band FM wave.

(i) Determine the envelope of this modulated wave. What is the ratio of maximum to minimum amplitudes ? *5*

(ii) Determine the average power of NBFM. *5*

(iii) By expanding the angular argument $\theta(t) = 2\pi f_c t + \phi t$ of NBFM, wave s(t) in the form of a power series and restricting the modulation index β to a maximum value of 0·3 rad,

show that

$$\theta(t) = 2\pi f_c t + \beta \sin(2\pi f_m t) - \frac{\beta^3}{3} \sin^3(2\pi f_m t)$$

Compute the value of Harmonic distortion for $\beta = 0{\cdot}3$ rad. *10*

(b) A unity feedback system has a loop transfer function

$$L(s) = \frac{4(s+a)}{s(s+1)(s+3)}$$

(i) Draw the root locus as 'a' varies from '0' to 100. *10*

(ii) Using the root locus, estimate the percentage overshoot and settling time (with a 2% criterion) of the system at a = 2 and a = 4. *5*

(iii) Determine the actual overshoot and settling time at a = 2 and a = 4. *5*

(c) (i) Explain programming paradigms with examples. *10*

(ii) Write a pseudocode/program to sort given number. *10*

SECTION B

Q5. (a) (i) Let X be a random variable and let $Y = (X - \mu_X)/\sigma_X$. What is the mean and variance of the random variable Y ? *5*

(ii) Compute the mean of $e^{j\omega t}$ where ω is a random variable. *5*

(b) Describe the importance of photolithography in the fabrication of Integrated Circuits. How is the junction depth determined after the diffusion of n-type dopants in a p-type substrate with a background concentration of $10^{15}/cm^3$? *10*

(c) Explain the following terms with example : *10*

(i) Attribute

(ii) Domain

(iii) Entity

(iv) Relationship

(d) A reflector antenna used for a cellular base station backhaul ratio link operates at 38 GHz with a gain of 39 dB, a radiation efficiency of 90%, and a diameter of 30 cm. Find the aperture efficiency of this antenna. *10*

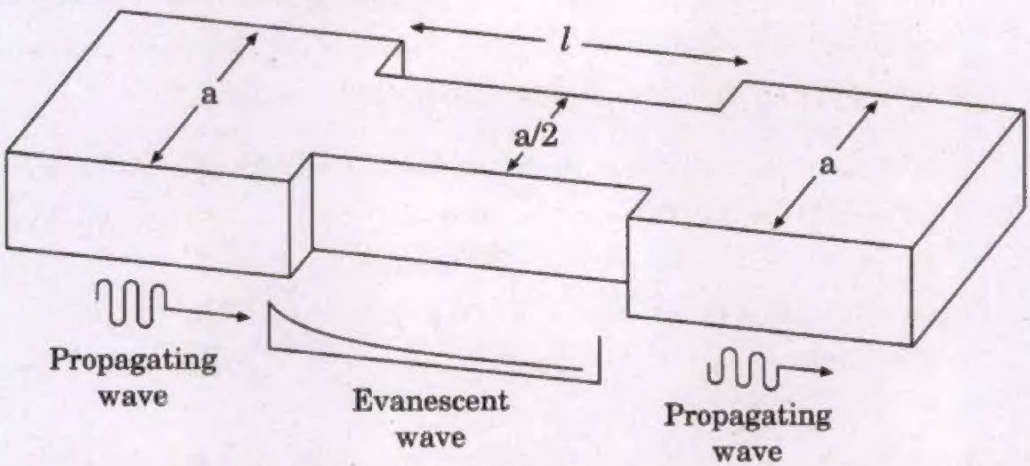
(e) Design a pipelined architecture to compute the value of the following summation by using 8-bit adders and 8-bit registers :

$$Sum = A + B + C + D + E + F + G + H$$

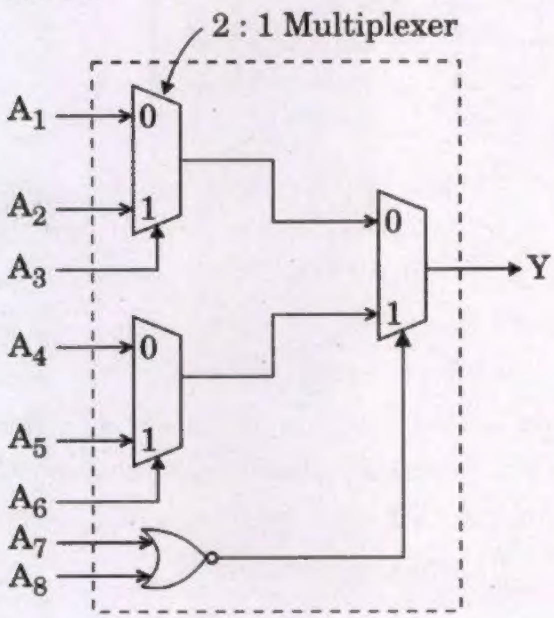
Assume that all the inputs are of 8-bits and the output 'Sum' is also restricted to 8-bits. Moreover, all the inputs and outputs are registered. Also compute its latency. *10*

(f) Write down the procedure to compute orthogonal basis function for two given signals ($x_1(t)$ and $x_2(t)$). *10*

Q6. (a) An attenuator can be made using a section of waveguide operating below cutoff as shown in the following figure. If a = 2·286 cm and operating frequency is 12 GHz, determine the required length of the below-cutoff section of a waveguide to achieve an attenuation of 100 dB between the input and output guides. The effect of reflections at the step discontinuities can be neglected. *20*



(b) Realize a full adder 'Sum = A ⊕ B ⊕ C in output by using only minimum number of multiplexer based logic blocks as shown below. The 'Sum' output is obtained by appropriately setting all the inputs of these logic blocks. *20*



Logic Block

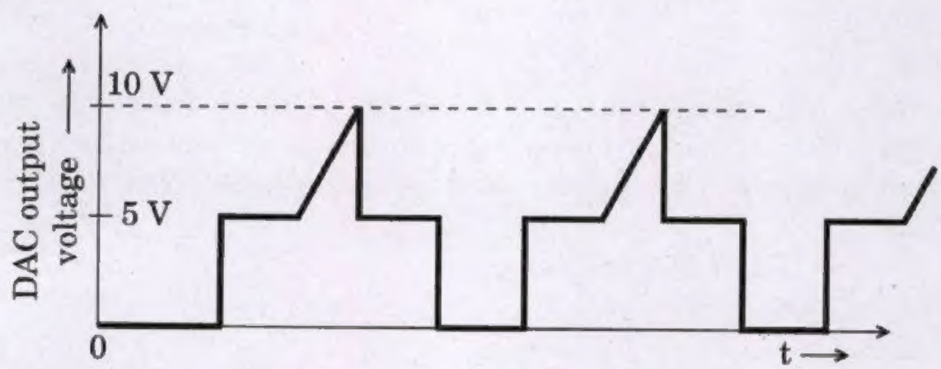
(c) Two multimode step index fibers have Numerical Aperture of 0·2 and 0·4 respectively. Both fibers have 1·48 as their refractive index of core. Calculate the insertion loss at a joint in each fiber caused due to 5° angular misalignment of axes of fiber core. Medium between fibers is air. *20*

Q7. (a) The radial component of the radiated power density of an antenna is given by

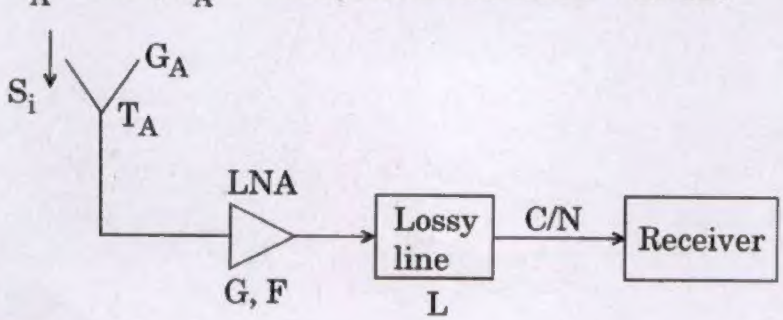
$$W_{rad} = \hat{a}_r W_r = \hat{a}_r A_0 \frac{\sin\theta}{r^2} \text{ W/m}^2$$

where 'A_0' is the peak value of the power density, 'θ' is the usual spherical coordinate, and '$\hat{a}_r$' is the radial unit vector. Find the maximum directivity of the antenna. Write an expression for the directivity as a function of directional angles 'θ' and 'ϕ'. *10+10*

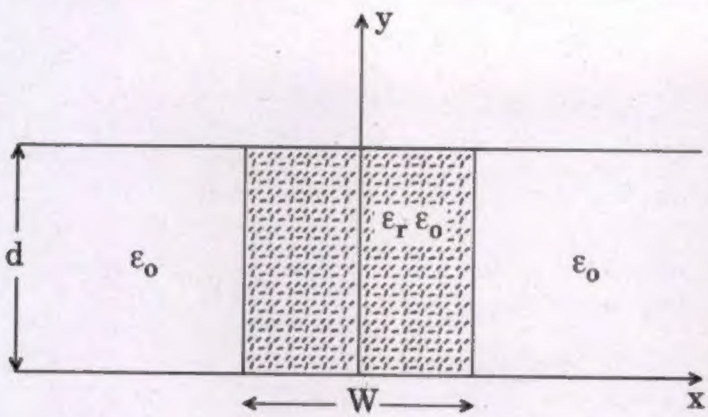
(b) Write an 8085 program to generate the following waveform with the help of 8085 microprocessor kit and an 8-bit DAC connected to an output port 'A' of 8255. The output voltage range of DAC is 0 V to 10 V. The addresses of port 'A' and Control register of 8255 are 00H and 03H respectively. *20*



(c) Consider the GPS receiver system given below. The guaranteed minimum L1 (1575 MHz) carrier power received by an antenna on Earth having a gain of 0 dBi is $S_i = -160$ dBW. A GPS receiver is usually specified as requiring a minimum carrier to noise ratio, relative to a 1 Hz BW, of C/N (Hz). If the receiver antenna actually has a gain G_A, and a noise temperature T_A, derive an expression for the maximum allowable amplifier noise figure, F, assuming an amplifier gain, G, and a connecting line loss, L. Evaluate this expression for C/N = 32 dB-Hz, G_A = 5 dB, T_A = 300 K, G = 10 dB and L = 25 dB. *20*



Q8. (a) Consider the partially filled parallel plate waveguide as shown below. Derive the solution (field and cutoff frequency) for the lowest order TE mode of this structure. Assume the metal plates are infinitely wide. *20*

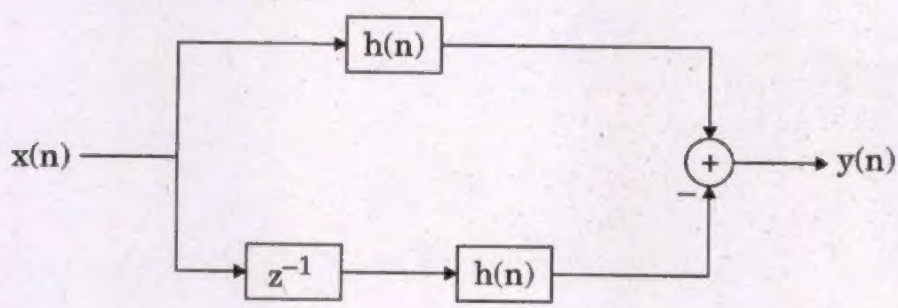


(b) (i) Find the response y(n) of the system shown below to the input

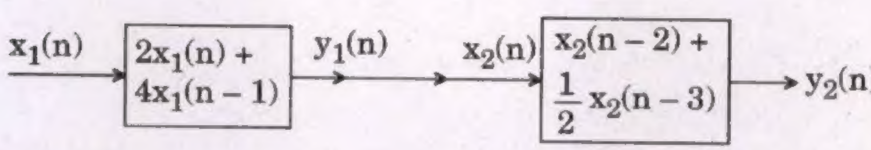
$$x(n) = u(n + 4) - u(n - 9)$$

where

$$h(n) = b^n u(n), \ -1 < b < 1.$$ *10*



(ii)



Determine input – output relationship between $x_1(n)$ and $y_2(n)$. Comment, when the sequence is reversed. *10*

(c) A 10 kW transmitter amplitude modulates a carrier with a tone $m(t) = \sin(2000 \pi t)$, using 50% modulation. Propagation losses between the transmitter and the receiver attenuate the signal by 90 dB. The receiver has a front-end noise $N_o = -113$ dBW/Hz and includes a BPF $B_T = 2\omega = 10$ kHz. What is the post-detection SNR, assuming the receiver uses an envelope detector ? *20*